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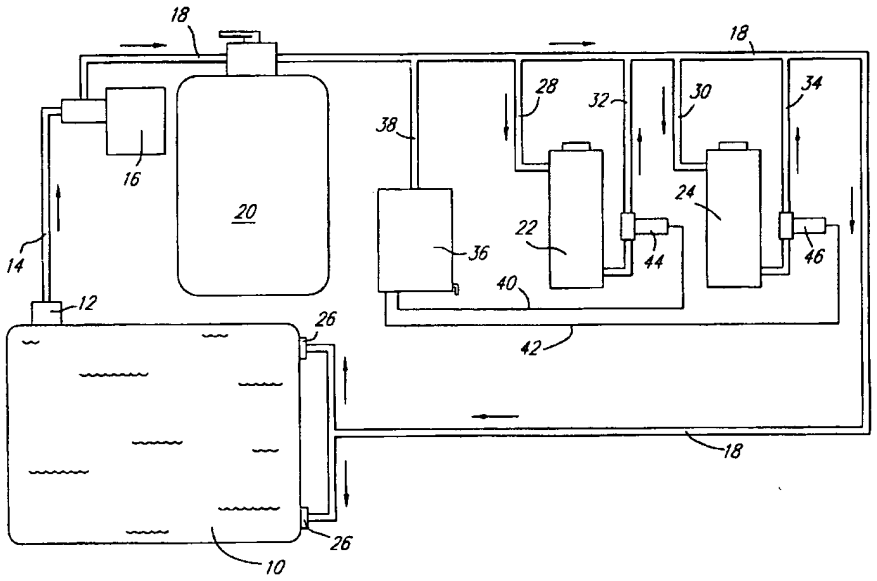
(54) **SYSTEME POUR LA SURVEILLANCE ET LA REGULATION AUTOMATIQUES DES PRODUITS CHIMIQUES UTILISES POUR L'ENTRETIEN DE L'EAU DES PISCINES**

(54) **AUTOMATIC CHEMICAL MONITOR AND CONTROL SYSTEM FOR SWIMMING POOLS**



(57) A chemical monitoring and controlling system for a reservoir of water having a recirculating water line, comprises a photometric analyzer including a sample cell in fluid communication with the recirculating water line for holding a sample of water from the reservoir, the analyzer providing a first output signal indicative of the concentration of chemical in the water sample; at least one coloring reagent supply means in fluid communication with the sample cell; fluid control means for controlling the supply of water and coloring reagent to the sample cell; comparator means coupled to the analyzer for comparing the first output signal with a predetermined reference value and providing a second output signal proportional to the difference therebetween when the first output signal varies from the predetermined reference value; and feed control means responsive to the second output signal for regulating supply of the chemical from a dispenser to the reservoir of water such that the concentration of the chemical therein reaches the predetermined reference value. The sample cell comprises a housing defining a sample chamber for containing the water sample in admixture with the coloring reagent and an air chamber communicating with the sample chamber, a water inlet and at least one coloring reagent inlet for receiving predetermined quantities of water and coloring reagent, the water inlet and the coloring reagent inlet merging into a tubular member having a constricted end portion opening into the sample chamber for discharging thereinto the mixture of water and coloring reagent, the constricted end portion providing uniform mixing of the water and the coloring reagent, and fluid discharge means for emptying the sample chamber.

The present invention relates to an automatic chemical monitoring and controlling system for a reservoir of water having a recirculating water line. More particularly, the invention is directed to an automatic halogen and pH controller for swimming pools.

Swimming pools provide a great deal of recreational pleasure. The pleasure derived from a swimming pool is essentially dependent upon the quality of the water in the pool. To assure comfort and safety to the swimmers using the pool, it is essential that the water be properly treated chemically. Chemical treatment of swimming pool water primarily involves two pool water tests: one for halogen such as chlorine or bromine, and the other for pH.

A halogen residual must be maintained in the pool water for effective sterilization. If too little halogen is supplied to the water, not all bacteria will be removed from the water. Proper pH control is also essential to the correct operation of a pool as the microbicidal activity of the halogen is pH dependent. The pH value of the swimming pool water expresses its acid-alkali ratio. A desirable pH range for pool operation is pH 7.4 to pH 7.6. Lower pH values tend to accelerate the loss of halogen and cause excessive eye irritation, corrosion of metal components and possible etching of the pool's interior. Higher pH values slow the microbicidal function of the halogen and can produce scale formation on the pool's interior, piping and heater coils.

Various chemical control systems have been proposed for automatically controlling the halogen and pH balance of swimming pools. The control systems described in US Patent Nos. 4,224,154 and 5,422,014, for instance, require the use of two electrodes: one

for measuring the pH of the water, and the other for measuring the oxygen reduction potential and therefore the concentration of oxidizing agents such chlorine or bromine in the water. These electrodes are not only costly but also require periodic replacement. In US Patent No. 4,016,079, on the other hand, measurement of the halogen concentration and pH is effected by photometric colorimetry. A water sample and a coloring reagent are introduced into a sample cell which is a mechanically actuated syringe having a piston movable therein. Partial withdrawal of the piston from the sample cell causes the water sample and coloring reagent to be introduced separately into the interior of the sample cell. Such a mechanical arrangement does not provide a uniform mixing of the water and coloring reagent, which is essential for a complete reaction of the coloring reagent with the water sample. Moreover, any air bubbles introduced into the sample cell cannot escape so that the measurement of absorbency is disturbed.

It is therefore an object of the present invention to overcome the above drawbacks and to provide an improved chemical monitoring and controlling system.

In accordance with the present invention, there is thus provided a chemical monitoring and controlling system for a reservoir of water having a recirculating water line, which system comprises:

- photometric analyzer means including a sample cell in fluid communication with the recirculating water line for holding a sample of water from the reservoir, the analyzer means providing a first output signal indicative of the concentration of chemical in the water sample;

- at least one coloring reagent supply means in fluid communication with the sample cell;

- fluid control means for controlling the supply of water and coloring reagent to the sample cell such as to allow the introduction of predetermined quantities of water and coloring reagent into the sample cell at preselected time intervals;

- comparator means coupled to the analyzer means for comparing the first output signal with a predetermined reference value and providing a second output signal proportional to the difference therebetween when the first output signal varies from the predetermined reference value; and

- feed control means responsive to the second output signal for regulating supply of the chemical from a dispenser to the reservoir of water such that the concentration of the chemical therein reaches the predetermined reference value.

According to the invention, the sample cell comprises a housing defining a sample chamber for containing the water sample in admixture with the coloring reagent and an air chamber communicating with the sample chamber, air intake means opening into the sample chamber above the mixture of water and coloring reagent, a water inlet and at least one coloring reagent inlet for receiving the predetermined quantities of water and coloring reagent, the water inlet and the at least one coloring reagent inlet merging into a tubular member having a constricted end portion opening into the sample chamber for discharging thereinto the mixture of water and coloring reagent, the constricted end portion providing uniform mixing of the water and the coloring reagent, and fluid discharge means for emptying the sample chamber.

The provision of the above tubular member with a constricted end portion, into which merges the water inlet and the at least one coloring reagent inlet, ensures rapid and uniform mixing of the water and coloring reagent. On the other hand, the provision of an air chamber communicating with the sample chamber permits the elimination of any air bubbles from the mixture of water and reagent in the sample chamber, which air bubbles may have been generated during mixing of the water and reagent, so that the measurement of absorbency by the photometric analyzer is not disturbed.

In a preferred embodiment of the invention, there are two coloring reagent supply means each supplying a different coloring reagent and the fluid control means are operative to sequentially introduce into the sample cell a first water sample from the water line along with a first coloring reagent from one of the coloring reagent supply means, and a second water sample from the water line along with a second coloring reagent from the other coloring reagent supply means. When the first coloring reagent is a halogen reagent, the first output signal from the analyzer means is indicative of the concentration of halogen in the first water sample and the feed control means are operative to regulate supply of halogen from a first dispenser to the reservoir of water. When the second coloring reagent is a pH reagent, the first output signal from the analyzer means is indicative of the pH of the second water sample and the feed control means are operative to regulate supply of a pH compensation substance from a second dispenser to the reservoir of water. In such an embodiment, the sample cell comprises two coloring reagent inlets each in fluid communication

with a respective one of the coloring reagent supply means.

According to a particularly preferred embodiment of the invention, the air chamber of the sample cell is disposed directly above the sample chamber and the tubular member extends downwardly through the air chamber. The housing comprises an upper portion defining the air chamber and a lower portion defining the sample chamber, the lower housing portion being connected to the upper housing portion and having a peripheral wall formed of transparent material. Preferably, the water inlet, the coloring reagent inlets and the tubular member are integral with the upper housing portion and the air intake means comprises a tube integral with the lower housing portion.

The present invention also provides, in another aspect thereof, a photometric sample cell comprising a housing defining a sample chamber for containing a sample of liquid in admixture with a coloring reagent and an air chamber communicating with the sample chamber, air intake means opening into the sample chamber above the mixture of liquid and coloring reagent, a liquid inlet and at least one coloring reagent inlet for receiving predetermined quantities of liquid and coloring reagent, the liquid inlet and the at least one coloring reagent inlet merging into a tubular member having a constricted end portion opening into the sample chamber for discharging thereinto the mixture of liquid and coloring reagent, the constricted end portion providing uniform mixing of the liquid and the coloring reagent, and fluid discharge means for emptying the sample chamber.

Further features and advantages of the invention will become more readily apparent from the following description of a preferred embodiment as illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a schematic illustration of a swimming pool water recirculating system incorporating an automatic halogen and pH controller according to a preferred embodiment of the invention;

Figure 2 is a schematic illustration of the halogen and pH controller shown in Fig. 1;

Figure 3 is a sectional view of the sample cell shown in Fig. 2; and

Figure 3A is an enlarged, fragmented sectional view of the portion encircled in Fig. 3.

Referring first to Fig. 1, there is illustrated a swimming pool water recirculating system including a pool 10 having a skimmer 12 through which water passes to a conduit 14 leading to a pump 16. Pump 16 forces the water through line 18, filter 20, dispenser 22 for supplying halogen to the water and dispenser 24 for supplying a pH compensation substance thereto, the water returning to the pool 10 through inlets 26. The dispensers 22 and 24 have inlet conduits 28,30 and outlet conduits 32,34, respectively. An automatic halogen and pH controller 36 is connected to the water line 18 via conduit 38. The controller 36 is electrically connected via leads 40 and 42 to solenoid valves 44 and 46 which are connected to conduits 32 and 34, respectively.

Turning to Fig. 2, the halogen and pH controller 36 has a housing 48 in which is arranged a photometric analyzer 50 comprising a sample cell 52 for holding a sample of water from the pool 10, a light

source 54 disposed proximate the sample cell 52 to project light thereon from one side and a photocell 56 disposed on the side of the sample cell opposite the light source 54 to receive light passing through the sample cell and the liquid contained therein. The light source 54 and photocell 56 are electrically connected to a microprocessor 58 via leads 60 and 62, respectively. The sample cell 52 has a water inlet 64 which is connected via solenoid valve 66 to conduit 38 extending through the housing 48. Solenoid valve 66 is electrically connected to the microprocessor 58 via lead 68. Two containers 70 and 72 are provided for supplying a liquid halogen reagent and a liquid pH reagent to the sample cell 52, the halogen reagent container 70 and the pH reagent container 72 having outlet conduits 74 and 76, respectively. The sample cell 52 includes two reagent inlets 78 and 80 which are connected via solenoid valves 82,84 to the outlet conduits 74 and 76, respectively, of containers 70,72. Solenoid valves 82 and 84 are electrically connected to the microprocessor 58 via leads 86 and 88. The sample cell 52 is provided with a fluid discharge outlet 90 for emptying the cell, the outlet 90 being connected via solenoid valve 92 to a drain conduit 94 extending through the housing 48. Solenoid valve 92 is electrically connected to the microprocessor 58 via lead 96.

As shown in Fig. 3, the sample cell 52 comprises a housing 98 having an upper portion 100 defining an air chamber 102 and a lower portion 104 defining a sample chamber 106 for containing the water sample in admixture with one of the reagents, the mixture of water and reagent being designated by reference numeral 108 shown in Fig. 2. The air chamber

102 is directly above the sample chamber 106 and communicates therewith. The lower housing portion 104 has a peripheral wall 110 of cylindrical configuration formed of transparent material such as glass. The lower housing portion 104 is connected to the upper housing portion 100 by means of a peripheral rib 112 which is engaged in a recess 114 formed in the cylindrical wall 116 of the upper housing portion 100, as best shown in Fig. 3A. The water inlet 64 and reagent inlets 78,80 extend though the upper housing portion 100 and merge into a tubular member 118 extending downwardly through the air chamber 102. The tubular member 118 has a constricted end portion 120 opening into the sample chamber 106 for discharging thereinto the mixture of water and reagent, the constricted end portion 120 providing uniform mixing of the water and reagent introduced via the water inlet 64 and one of the reagent inlets 78,80. As shown, the water inlet 64 extends coaxially with the tubular member 118. The reagent inlets 78 and 80 each extend upwardly from the tubular member 118 at an acute angle relative to the longitudinal axis thereof.

An air intake tube 122 extending through the lower housing portion 104 and opening into the sample chamber 106 above the mixture 108 of water and reagent is provided for maintaining the air chamber 102 at atmospheric pressure and allowing the sample chamber 106 to be emptied when solenoid valves 66, 82 and 84 are closed and the solenoid valve 92 is opened. The provision of air chamber 102 communicating with the sample chamber 106 permits the elimination of air bubbles from the mixture 108 of water and reagent in the sample chamber 106, which air bubbles may have been generated during mixing of the water and reagent, so

that the measurement of absorbency by the photocell 56 is not disturbed.

The water inlet 64, reagent inlets 78,80 and tubular member 118 are integral with the upper housing portion 100 and may be formed of plastic material. The fluid discharge outlet 90 and air intake tube 122, on the other hand, are integral with the lower housing portion 104. Opening of the air intake tube 122 in the sample chamber 106 prevents formation of a water plug in the tubular member 118. As shown, the air intake tube 122 opens in the sample chamber 106 below the constricted end portion 120 of tubular member 118.

The microprocessor 58 includes a fluid control circuit (not shown) for controlling solenoid valves 66, 82 and 84 such as to allow the introduction of predetermined quantities of water and reagent into the sample chamber 106 of cell 52 at preselected time intervals. The fluid control circuit is operative to sequentially actuate valves 66,82 and valves 66,84 and thereby introduce into the sample cell 52 a first water sample along with halogen reagent from the halogen reagent container 70, and thereafter a second water sample along with pH reagent from the pH reagent container 72. After the reagent and water sample mix and react, a change of color of the water sample occurs. When the reagent introduced in the sample cell 52 is a halogen reagent, the output signal from the photocell 56 is indicative of the concentration of halogen in the water sample. On the other hand, when the reagent introduced in the cell 52 is a pH reagent, the output signal from the photocell 56 is indicative of the pH of the water sample The microprocessor 58 further includes a comparator circuit (not shown) for comparing the output signal from the photocell 56 with

a predetermined reference value and providing an output signal proportional to the difference therebetween when the output signal from the photocell 56 varies from the predetermined reference value, as well as a feed control circuit (not shown) which is responsive to the output signal from the comparator circuit for providing a command signal which is transmitted via lead 40 or 42 to solenoid valve 44 or 46 such as to regulate the supply of halogen or pH compensation substance from the dispenser 22 or 24 to the water. The microprocessor 58 also controls the light source 54 and solenoid valve 92.

The controller 36 thus enables one to automatically monitor and control the halogen concentration and pH of swimming pool water in a simple and economic manner.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A chemical monitoring and controlling system for a reservoir of water having a recirculating water line, said system comprising:

- photometric analyzer means including a sample cell in fluid communication with said recirculating water line for holding a sample of water from said reservoir, said analyzer means providing a first output signal indicative of the concentration of chemical in the water sample;

- at least two coloring reagent supply means in fluid communication with said sample cell and each supplying a different coloring agent;

- fluid control means for controlling the supply of water and coloring reagent to said sample cell such as to allow the introduction of predetermined quantities of water and coloring reagent into said sample cell at preselected time intervals;

- comparator means coupled to said analyzer means for comparing said first output signal with a predetermined reference value and providing a second output signal proportional to the difference therebetween when said first output signal varies from said predetermined reference value; and

- feed control means responsive to said second output signal for regulating supply of said chemical from a dispenser to said reservoir of water such that the concentration of said chemical therein reaches said predetermined reference value;

wherein said sample cell comprises a housing defining a sample chamber for containing said water sample in

admixture with said coloring reagent and an air chamber communicating with said sample chamber, air intake means opening into said sample chamber above the mixture of water and coloring reagent, a water inlet and at least one coloring reagent inlet for receiving said predetermined quantities of water and coloring reagent, said water inlet and said at least one coloring reagent inlet merging into a tubular member having a constricted end portion opening into said sample chamber for discharging thereinto said mixture of water and coloring reagent, said constricted end portion providing uniform mixing of said water and said coloring reagent, and fluid discharge means for emptying said sample chamber, and wherein said fluid control means are operative to sequentially introduce into said sample cell a first water sample from said water line along with a first coloring reagent from one of said coloring reagent supply means, and a second water sample from said water line along with a second coloring reagent from the other of said coloring reagent supply means.

2. A system as claimed in claim 1, wherein one of said coloring reagent is a halogen reagent and the other coloring reagent is a pH reagent.

3. A system as claimed in claim 2, wherein when said first coloring reagent is a halogen reagent said first output signal from said analyzer means is indicative of the concentration of halogen in said first water sample, and wherein said feed control means are operative to regulate supply of halogen from a first dispenser to said reservoir of water.

4. A system as claimed in claim 3, wherein when said second coloring reagent is a pH reagent said first output signal from said analyzer means is indicative of the pH of said second water sample, and wherein said feed control means are operative to regulate supply of a pH compensation substance from a second dispenser to said reservoir of water.

5. A system as claimed in claim 1, wherein said sample cell comprises two said coloring reagent inlets each in fluid communication with a respective one of said coloring reagent supply means.

6. A system as claimed in claim 5, wherein said air chamber is disposed directly above said sample chamber and said tubular member extends downwardly through said air chamber.

7. A system as claimed in claim 6, wherein each said coloring reagent inlet extends upwardly from said tubular member at an acute angle relative to a longitudinal axis thereof.

8. A system as claimed in claim 6, wherein said water inlet extends coaxially with said tubular member and is integral therewith.

9. A system as claimed in claim 6, wherein said air intake means opens into said sample chamber below the constricted end portion of said tubular member.

10. A system as claimed in claim 6, wherein said housing comprises an upper portion defining said air chamber and a lower portion defining said sample

chamber, the lower housing portion being connected to the upper housing portion and having a peripheral wall formed of transparent material.

11. A system as claimed in claim 10, wherein said water inlet, said coloring reagent inlets and said tubular member are integral with said upper housing portion.

12. A system as claimed in claim 10, wherein said air intake means comprises a tube integral with said lower housing portion.

13. A system as claimed in claim 10 or 12, wherein said transparent material comprises glass.

14. A photometric sample cell comprising a housing defining a sample chamber for containing a sample of liquid in admixture with a coloring reagent and an air chamber communicating with said sample chamber and disposed directly thereabove, air intake means opening into said sample chamber above the mixture of liquid and coloring reagent, a liquid inlet and at least one coloring reagent inlet for receiving predetermined quantities of liquid and coloring reagent, said liquid inlet and said at least one coloring reagent inlet merging into a tubular member extending downwardly through said air chamber and having a constricted end portion opening into said sample chamber for discharging thereinto said mixture of liquid and coloring reagent, said constricted end portion providing uniform mixing of said liquid and said coloring reagent, and fluid discharge means for emptying said sample chamber.

15. A cell as claimed in claim 14, wherein said housing comprises an upper portion defining said air chamber and a lower portion defining said sample chamber, the lower housing portion being connected to the upper housing portion and having a peripheral wall formed of transparent material.

16. A cell as claimed in claim 15, wherein said water inlet, said at least one coloring reagent inlet and said tubular member are integral with said upper housing portion.

17. A cell as claimed in claim 15, wherein said air intake means comprises a tube integral with said lower housing portion.

18. A cell as claimed in claim 17, wherein said transparent material comprises glass.

ABSTRACT

A chemical monitoring and controlling system for a reservoir of water having a recirculating water line, comprises a photometric analyzer including a sample cell in fluid communication with the recirculating water line for holding a sample of water from the reservoir, the analyzer providing a first output signal indicative of the concentration of chemical in the water sample; at least one coloring reagent supply means in fluid communication with the sample cell; fluid control means for controlling the supply of water and coloring reagent to the sample cell; comparator means coupled to the analyzer for comparing the first output signal with a predetermined reference value and providing a second output signal proportional to the difference therebetween when the first output signal varies from the predetermined reference value; and feed control means responsive to the second output signal for regulating supply of the chemical from a dispenser to the reservoir of water such that the concentration of the chemical therein reaches the predetermined reference value. The sample cell comprises a housing defining a sample chamber for containing the water sample in admixture with the coloring reagent and an air chamber communicating with the sample chamber, a water inlet and at least one coloring reagent inlet for receiving predetermined quantities of water and coloring reagent, the water inlet and the coloring reagent inlet merging into a tubular member having a constricted end portion opening into the sample chamber for discharging thereinto the mixture of water and coloring reagent, the constricted end portion providing uniform mixing of the water and the coloring reagent, and fluid discharge means for emptying the sample chamber.

ABSTRACT

A chemical monitoring and controlling system for a reservoir of water having a recirculating water line, comprises a photometric analyzer including a sample cell in fluid communication with the recirculating water line for holding a sample of water from the reservoir, the analyzer providing a first output signal indicative of the concentration of chemical in the water sample; at least one coloring reagent supply means in fluid communication with the sample cell; fluid control means for controlling the supply of water and coloring reagent to the sample cell; comparator means coupled to the analyzer for comparing the first output signal with a predetermined reference value and providing a second output signal proportional to the difference therebetween when the first output signal varies from the predetermined reference value; and feed control means responsive to the second output signal for regulating supply of the chemical from a dispenser to the reservoir of water such that the concentration of the chemical therein reaches the predetermined reference value. The sample cell comprises a housing defining a sample chamber for containing the water sample in admixture with the coloring reagent and an air chamber communicating with the sample chamber, a water inlet and at least one coloring reagent inlet for receiving predetermined quantities of water and coloring reagent, the water inlet and the coloring reagent inlet merging into a tubular member having a constricted end portion opening into the sample chamber for discharging thereinto the mixture of water and coloring reagent, the constricted end portion providing uniform mixing of the water and the coloring reagent, and fluid discharge means for emptying the sample chamber.

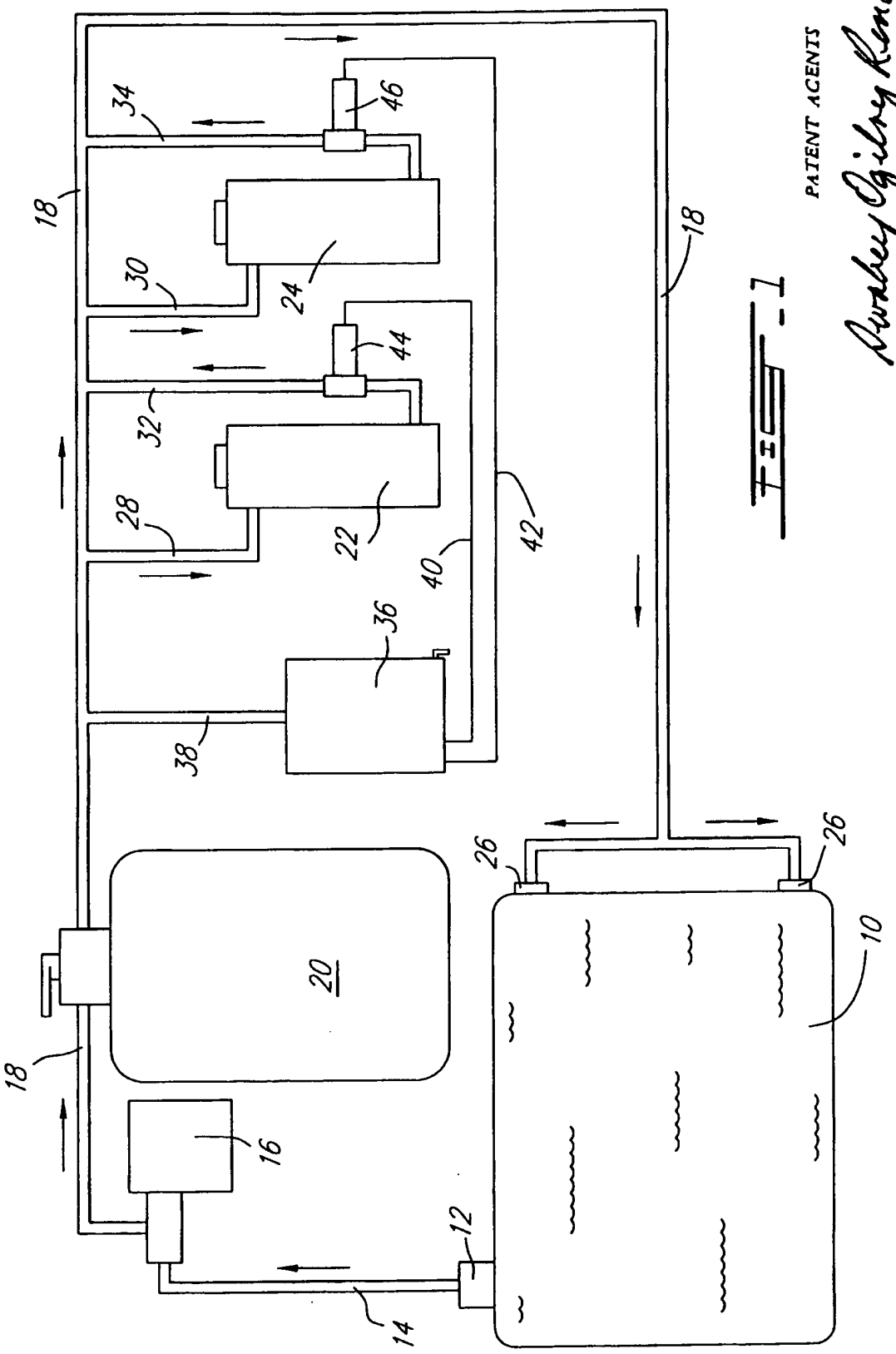


Fig. 1

PATENT AGENTS

Rowley Quilty Rowsell

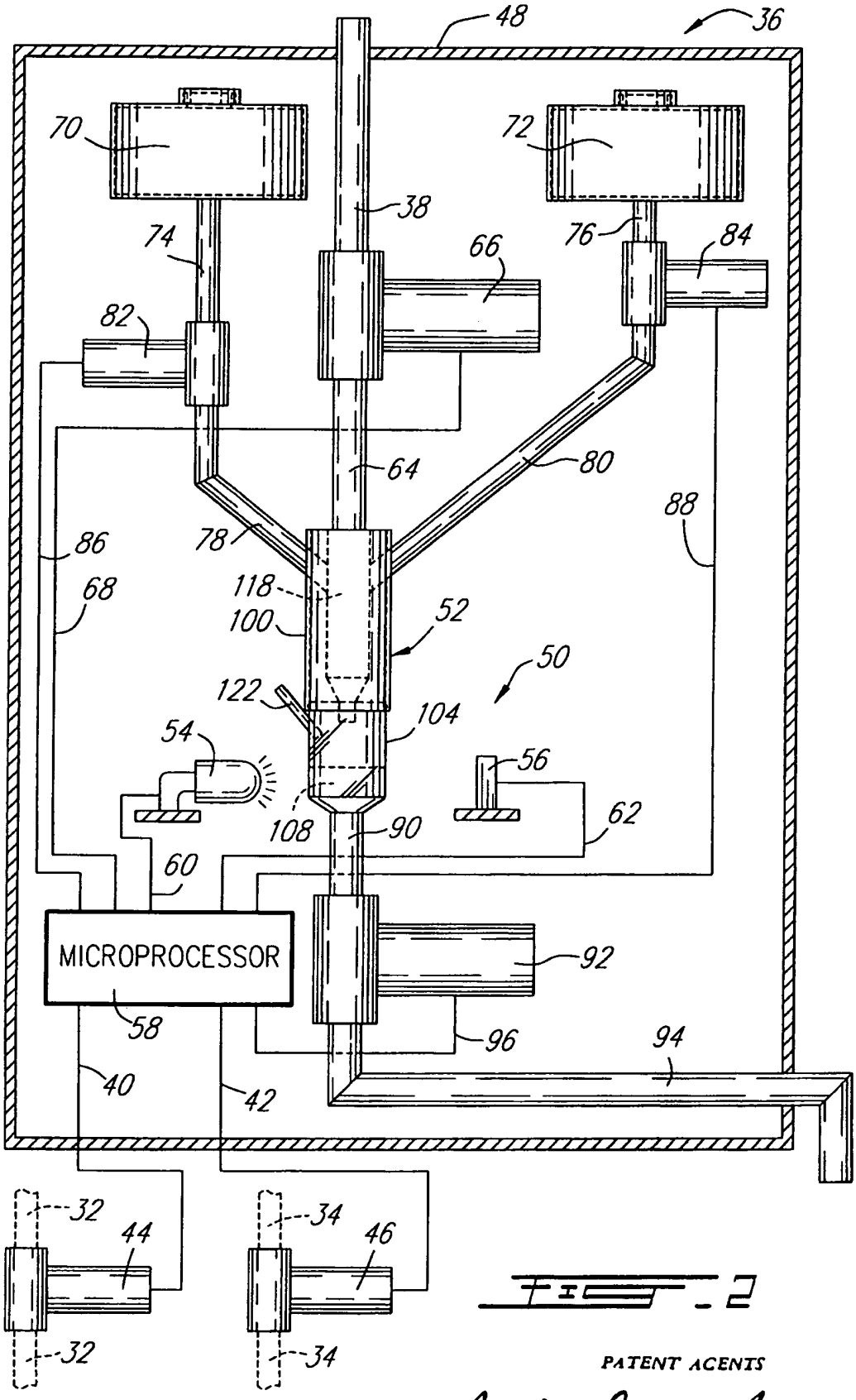
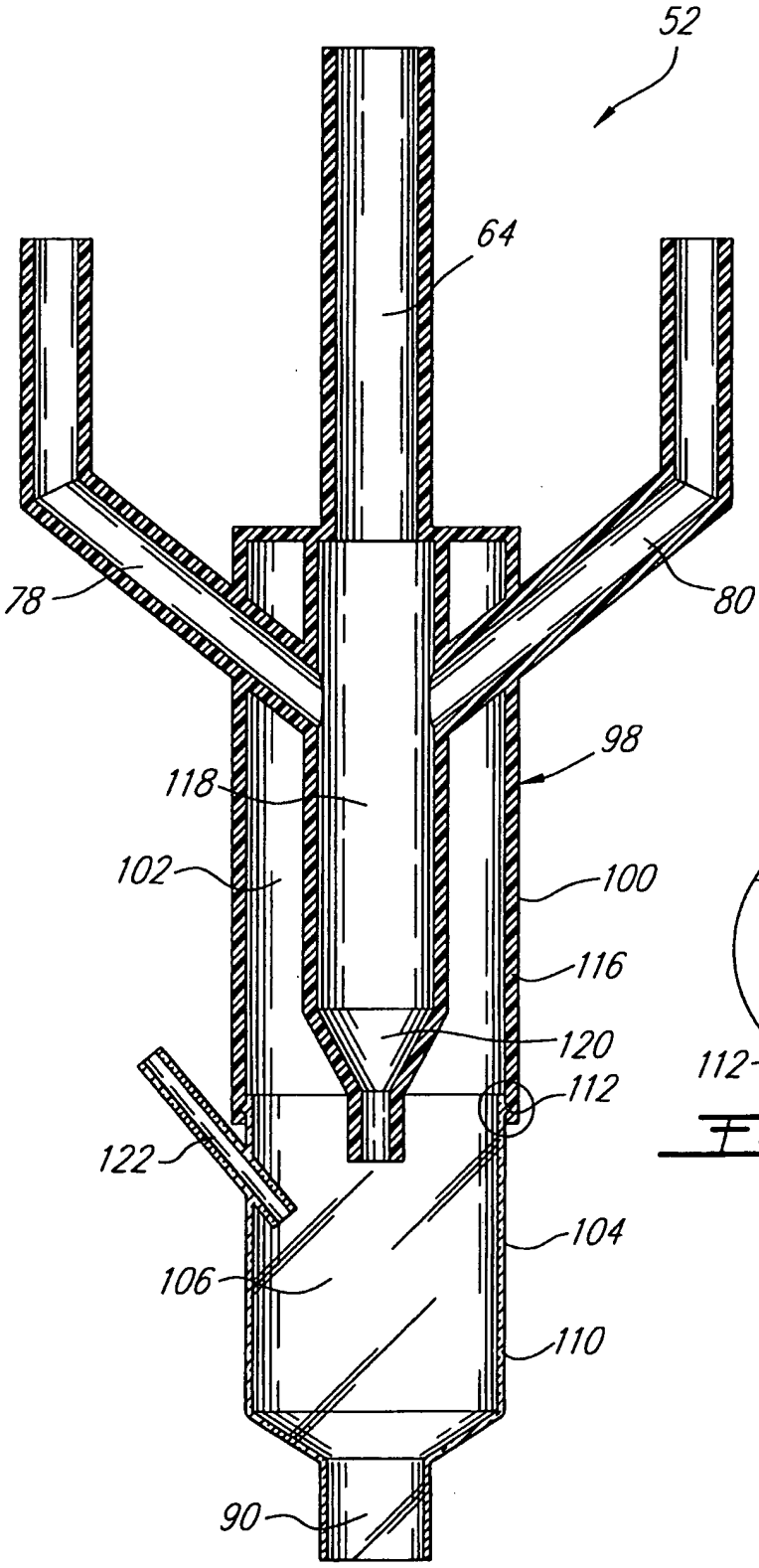


FIG. 2

PATENT AGENTS

Swabey Ogilvy Renault



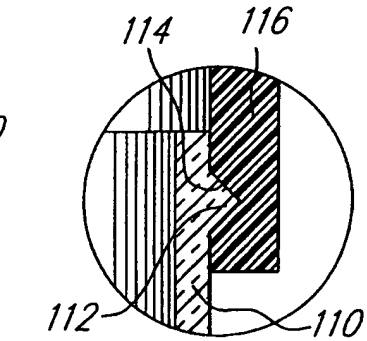


FIG - 3A

FIG - 3

PATENT AGENTS

Dowbey Ogilvy Renault